The latest Pew study (http://www.pewinternet.org/Reports/2010/Mobile-Access-2010.aspx?r=1) documents the importance of mobile, wireless broadband access.

"Thirty eight percent of U.S. adults now access the Internet via mobile phone--up from 25 percent a year ago--according to a new survey published by the Pew Internet & American Life Project. With 47 percent of respondents going online via laptop connected to a WiFi connection or mobile broadband card (up from 39 percent in April 2009), Pew notes that 59 percent of American adults now access the web wirelessly using a laptop or handset, an 8 percent year-over-year increase.

African-Americans and English-speaking Latinos are at the forefront of mobile web growth in the U.S. Pew reports that mobile handset ownership is higher among African-Americans and Latinos than among whites (87 percent versus 80 percent), with minority subscribers leveraging a much greater range of mobile data services--64 percent of African-Americans now access the mobile web, growing from 57 percent in 2009.

Although young adults between the ages of 18 and 29 remain the most avid mobile data consumers, the survey notes that older adults are gaining fast, and are now significantly more likely to embrace non-voice functions. Seventy six percent of U.S. adults now snap photos with their phones, up from 66 percent a year ago; 72 percent send and receive text messages (up from 65 percent), 34 percent play mobile games (up from 27 percent), 34 percent record videos (up from 19 percent) and 33 percent play music (up from 21 percent)."

The Pew study demonstrates that wireless, mobile and nomadic broadband, is becoming the dominant method of US Internet access and is disproportionately important to minorities and youth.

 â€¢ 60% of US adults access the Internet wirelessly,
 â€¢ 50% of US adults access the Internet via unlicensed WiFi
 â€¢ 40% of US adults access the Internet via licensed service provider access
 â€¢ 85% of laptop users access the Internet via unlicensed WiFi.

It is clear that effective, ubiquitous, high performance mobile, wireless broadband will be a critical component of our future US commercial, industrial, and educational productivity â€¦ as well as for leisure. Â Â Â And that mobile access includes both licensed and unlicensed services.

Before we can establish policy - we need to understand the facts of state of mobile broadband - we need to measure it.

Novarum is wireless consulting firm founded by leaders in wireless products based on the premise that policy must be based on facts - not truthiness. Â To this end, Novarum has measured, on the

ground, over 300 wireless networks over the last four years - 2,3 and 4G cellular, WiFi, WiMax and proprietary wireless technologies both for service providers and enterprises. Â Â Â This unique database of network measurement informs our judgement as to the relative performance of different technologies, user devices, Â and deployment strategies.

We have learned three key values from this experience that guide good measurement: Â

 â€¢ Network performance must be judged by the end user experience and that internal measurement by the network itself is never sufficient. Â Â The network experience must be evaluated end-to-end just as the user experiences it.
 â€¢ Mobile broadband performance measurement must include the entire end-to-end system that the user sees it - radio, routing and backhaul to get a true assessment of the user experience.
 â€¢ Passive and crowd sourced measurement alone is insufficient, effective network assessment requires disciplined, statistically meaningful pro-active on-the-ground measurement.

There exists very incomplete information today, largely service provider supplied, that describes both availability and performance of mobile broadband. Â Â Often this data is so incomplete or vague as to be useless in assessing consumer choice or regulator options. Â Â It is essential to have a modern, transparent, technology and service provider independent measurement method that gives consumers and regulators the information necessary to make informed choices. Â Â This measurement data does not replace service provider internal testing - rather it complements it. Â Â Service provider testing provides valuable internal diagnostics, but is proprietary, non-transparent, unavailable (except in vague summary form) and is oriented primarily towards internal network diagnostics rather than the user experience. Â Â

Proper consumer and regulator information requires measurement that reflects the common packet network operations we all use every day, measured independent of quickly evolving technology that allows all of us to appropriately understand the choices between technologies and providers. A wide variety of network technologies and new advanced radio technologies (e.g. MIMO, beam-forming) that can work in both licensed and unlicensed bands.

All of the important voice and data applications over the next decade are basically packet based using either datagram (UDP) or virtual circuit (TCP) based packet protocols for transmission. Â Â Simple metrics of packet delivery allow us to compare dissimilar networks that support these basic services.

Novarum has actively surveyed all of the major carrier networks, some the largest municipal WiFi networks in North America (City of Minneapolis, City of Riverside and many others) and helped invent some of Â the core technology.

In partnership with PC World Novarum has conducted a 3 and 4G tracking study of user mobile broadband performance first in 2Q2009 (http://www.pcworld.com/article/167391/a_day_in_the_life_of_3g.html) and then again in 1Q2010 (http://www.pcworld.com/article/189592/atandt_roars_back_in_pcworlds_second_3g_wireless_performance_test.html) - documenting not only relative performance between laptops and smartphones, but also between carriers and changes in network performance over time. Â Â The more complete analysis of these results is available for download at Novarumâ€™s publication web page (http://www.novarum.com/publications.php). Â Â We believe these to be the only statistically interesting non service provider supplied mobile performance data available.

We believe that accurate measurement of US mobile broadband is a strategic asset for consumers, enterprises, regulators, government and service providers.

What are the best measurement metrics for mobile broadband services?

Measurement of visibility (can a user device â€œseeâ€ the network), availability (can a user device successfully use the network), TCP throughput, UDP latency, packet loss and jitter capture the key items of modern packet network performance that allow us to well characterize and compare networks of differing underlying implementations. Â Mobile differs from fixed Internet access in that access can be stationary indoors or outdoors, or in vehicular motion outdoors. Â Â A comprehensive measurement should be able to assess all these modes of mobile access. Â Â Novarum has found that several measurements per square mile outdoors (in urban areas - less for rural) for most service provider networks give a good assessment of the quality of that network. Â Â Â Rapid mobile technology changes over the next 5 years suggest that structured measurement every six months is warranted.

Ultimately, the key issue of consumers and regulators is the end-to-end performance of the network. Â Â The goal is not to manage providers networks, but rather to provide performance, availability and coverage information to inform consumer purchase and regulatory policy.

Since most applications will be used both mobile and fixed modes and will share the same basic protocol architecture, similar basic processes and metrics should be shared for mobile and fixed networks. Â Â

User generated measurement, used alone, suffers a fatal flaw - immense selection bias. Â Â Â Â Â Â Â Users tend not to provide measurements of â€œtypicalâ€ ordinary network performance - rather measure extraordinary highs and lows and further, when network service is very slow or unavailable - crowd sourced measurement most often can not document the ABSENCE of

service.

Novarum strongly believes that the foundation of any measurement must be statistically valid pro-active sampling measurement of network performance. This eliminates most selection bias inherent in user-generated (crowd sourced) network measurement data.   We believe that user-generated data can be calibrated using pro-actively sampled data and thus used to expand the timeliness, reach and coverage of network measurement.

What are the best methods for collecting data on mobile broadband performance and coverage for endusers?

Ultimately the best mobile network measurement tool today is an end user (or a pro-active sampling surrogate) using their own mobile device using any number of publicly available tools.   The M-Lab tools being currently evaluated by the Commission are a good first step for an open source, transparent set of tools.   Each mobile device type is different and each user is different so this is the only reliable method today.   Simulations, RF extrapolations, inference from other user devices are very imperfect and tend to overstate network performance and coverage.

Sadly, the best specific testing tools are not well packaged for use - incompatible detailed (often proprietary) testing methodologies, poor data collection and aggregation tools and a lack of specific measurement and sampling methodology.   These tools need to executed on the end user device to a common testing server and reported, stored and made available at a common server. The Commission's investment in packaging and standardizing existing tools for ease of use, data collection and deployment would be highly worthwhile.

The Novarum/PC World study is today perhaps the best, impartial, assessment of 3 and 4G available today. Novarum's has done extensive work, using the same methodology, in measuring the real performance of municipal, WiMax and WiFi networks.   These results can be made available to the Commission.

How can user generated data (i.e., 'crowdsourcing') on mobile broadband network performance and coverage be utilized to assist in collecting data and improving transparency?

A software package on the end user device needs to do the measurement.   Such an application should register the availability of service, the location, and the key packet network performance metrics discussed above. Versions of the same test must be available for all the important end user mobile platforms.   The key issue is when and where the test is conducted.

Crowd sourced, user-generated data is at the mercy of when the user decides to do a measurement.

Â Â Only rarely do users do tests when service is "typical", rather they do tests when high or low performance is noted - or no results are reported when service is completely unavailable. Â Â Thus crowd sourcing does not report the complete user experience - it underreports unavailable service, over reports high performance and substantially underreports "typical" performance - when users are getting work done rather than being motivated to run a measurement.

This is why pro-active, randomly geographically distributed measurement is so important. Â Â It accurately assesses the both the "typical" performance, as well as discovering locations of no service and poor performance - as well as statistically accurately reporting high performance.

We believe that pro-active sampling measurement is essential to construct a baseline calibration that crowd-sourced data can be leveraged on.

In our experience, each user device has a different implementation of radio, network, operating system, antenna, and power. Â Â Network measurement will differ dramatically between different devices on the same network, at the same location and the same time. Â Â Measuring network performance for a representative set of currently available network devices is crucial for an accurate assessment of network performance. Â Â In our experience, the type of user device is one of the most significant, and under appreciated, Â variables in measuring network performance.

Measurements must label where they are taken with GPS coordinates and an indication of indoor, outdoors or in motion. Â Â Direct pro-active sampling easily does this. Â Â Crowd-sourced data must rely on the accuracy of the user supplied data.

GPS does a very good job of giving adequate position information. Â Â The challenge is that for many handset mobile devices, cellular service is required to get a GPS location - which means that adequately reporting where service is NOT is very hard for crowd-sourced data collection.

Pro-active sampling measurement needs to take enough samples to obtain a meaningful snapshot of the network. Â Â And then repeat periodically (say every six months) to track changes in overall network service. Â Â We believe that a meaningful sample can be constructed that is economical to implement.

For modern networks, the overhead of end user experience testing is a very light load for these networks and will introduce almost unmeasurable impact on overall network capacity and performance.

What are the benefits and costs of measurement for providers, regulators, customers and others?

Consumers, governments, businesses and regulators are largely in the dark today about the real performance and availability of mobile broadband networks. Â Â We rely almost entirely on the vague subset of data self-reported (and edited) by service providers. Â Â We see these arguments every day as consumers argue endlessly over which service provider is better than another based essentially on anecdotal information - or worse, on biased information provided by commercials.

The value of accurate comparative performance and coverage information for licensed and unlicensed mobile broadband service is of mission critical value for each consumerâ€™s purchase of mobile broadband, but also for enterprises and local governments as they provide service essential to our economy over these networks.

Making the right value choice of reliability, performance and coverage helps insure a rational market and incentives for investment and competition.

A constructive measurement plan that combines pro-active sampling and user generated measurement has modest costs of less than a penny per year per US adult. We believe that such a measurement program would have minimal impact on the network capacity and performance and is cheap at the price. Â Â Essentially minimal accurate, non-proprietary information exists today and the costs of ignorance are quite high.

There are clear privacy issues with crowd-sourcing that add to the difficulty of its accuracy. Â Â There are no privacy issues with pro-active sampling measurement.

Mobile broadband availability and performance information needs to be available both on applications on a userâ€™s mobile device - keyed to his location, service providers of choice and intended usage as well as via web based browser access.

How could information on mobile broadband performance and coverage be better communicated to consumers?

Mobile broadband performance and coverage information is, with the modest exception of such studies as the Novarum/PC World work, almost entirely reliant on self reported information from service providers. Â Â Almost no information is available on indoor service, specific performance in my geographic area, current network outages, or detailed coverage maps. Â Â What information there is often widely disbursed through a typical service providerâ€™s web site - in different, often hard to find locations.

For all practical purposes, there is, today, Â no trusted source for mobile broadband coverage and performance information.

What measurements are typically performed by service providers today to track mobile broadband network performance and service availability?

Every service provider does periodic pro-active drive tests to assess the performance of their networks as well network internal measurement tools. Â Â These tools are designed for service provider diagnostic of their network operation and only poorly document the actual delivered network service to end user devices.

Current service provider maps are, generally, of poor granularity and do not distinguish between service and performance available to different user devices (e.g. Laptop modems generally get much higher performance and coverage than some smartphones).

Signal strength is generally a poor predictor of user mobile broadband experience in most urban and suburban areas. Â Â Rather, these networks are most often congested either on the radio link or the backhaul link even with strong signal. Â Thus end-to-end network testing is only methodology that adequately measures the real user experience.

Novarum will be happy to provide the Commission with background of its measurement of mobile broadband networks.

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